example, as the Dardanelles Expedition—with regard to which it is recorded in Lord Fisher's "Memories"[3]: "The Cabinet Council reached its conclusions without drawing the opinion of the expert thereat for its guidance"—that the technical experts are ignored; on the contrary, many examples can be given of instances when, in relation both to important technical aspects of departmental policy and to simple matters of executive detail, the advice of the technicians has been overruled or not sought.

The root cause of the mischief under discussion lies in the system of the Civil Service. A privileged class has been allowed to grow up there, a class which, by reason of its proximity to the Minister and of the long service of the individual members composing it in one particular office, has obtained too great an influence, and is thus enabled to exercise an ascendancy not only over Ministers, who flit through their Departments, but also over those officials whose early years are spent on executive and technical duties.

The remedy for the present unsatisfactory state of affairs as regards the position of the technical expert is not far to seek. As matters stand to-day, the technical staffs in the Government Departments have too little influence and authority, whilst the Civil Service clerk has too much influence and an excess of authority. The disparity between the powers of these two classes is a source of public danger, and the way to obviate it is by a thorough reorganisation of the Civil Service and its system. What is required is that the chief administrative posts shall forthwith cease to be a monopoly of the clerical staffs. A suitable organisation for the Civil Service would be one which provided that entrants into every branch of it should, as a rule, begin their careers in an executive grade, and be promoted to occupy administrative posts at the headquarters of a Ministry or Department only after giving proof that they were familiar with the practical aspects of the matters they might be called on to administer. By the introduction of such an organisation into the Civil Service, it would be possible to select the best qualified officers in each branch for the important administrative posts, and, in consequence, render possible the adoption of a system whereby all matters referred to headquarters on which decisions have to be passed would come invariably before those who were experts in the particular subject upon which action had to be taken.

Aeronautical Research.

Applied Aerodynamics. By Leonard Bairstow. Pp. xii+566. (London: Longmans, Green, and Co., 1920.) Price 32*s.* net.

IMPATIENTLY as we have waited for the publication of this book, we feel that its appearance could scarcely have been more opportune. For here, as we believe, will be found abundant evidence in support of those who, like the Committee for Education and Research in Aeronautics, have striven to resist the break-up of our aerodynamics laboratories and design staffs. Research is always costly, aeronautical research superlatively so; and a public whose ear has been somewhat dulled by the insistence with which its claims were urged—not always wisely—during the war is somewhat naturally deafened now, by strident calls for economy, to any temperate statement of its claims. It is not promises that are wanted at the present time, to justify further expenditure, but a record of things achieved; and although the tangible results of British science and invention, as applied to the construction of aircraft, have appealed, and by the glamour of long-distance flying are still appealing, to the popular imagination, yet it has resulted from secrecy necessary in war time that the foundations upon which these successes have been built—the patient, detailed investigations which have supplied our designers with the data they required—are familiar only to a very few, being for the most part contained in reports of which the circulation, no less than the appeal, has been limited to specialists.

Now, within one volume of reasonable dimensions and large type, we are presented with an authoritative review of the work achieved by our research organisations during five years of strenuous activity. We have no fears that impartial judgment will pronounce the time and expenditure to have been wasted. Most branches of applied science have developed rapidly under the stimulus of war conditions, but of applied aerodynamics it might without serious exaggeration be said that the science has been created. The pioneer work is done, but to those who read Mr. Bairstow's book carefully it will be evident that on every side lie fields for research of which scarcely the surface has been broken, and that no mistake could be more disastrous, if we acknowledge the importance of aeronautics, than a refusal now to avail ourselves of the experience acquired by those few men to whom its present state of development is due.

We do not, of course, imply that the book is merely a record of war developments, still less an apologia for the aerodynamics laboratories. It is, both in intention and in effect, a handbook for the student, for the designer, and for the research worker, which assumes no previous knowledge in the reader, beyond the elements of hydrostatic theory, and illustrates the applications of aerodynamics in all its essential branches. Mr. Bairstow's qualifications for authorship are too well known to need description here. A leader in aerodynamic research at the National Physical Laboratory since the formation of the Advisory Committee for Aeronautics in 1909, his duties as expert adviser to the Air Board and Ministry during the war brought him into intimate contact with every side of aeronautical activity. Of great importance, in our opinion, is the fact that he has had first-hand acquaintance with research on both the model and the full-scale aeroplane, and so is entitled—whether we agree with his conclusions or not—to pronounce with authority upon the vexed questions which relate to "scale effect." But copious knowledge has not always, in the past, given us satisfactory text-books, and it is a real pleasure to find how well balanced is the structural scheme which Mr. Bairstow has devised. After touching lightly, but adequately, upon the early history of his subject, and having illustrated its present state of development by brief descriptions of typical modern aircraft and engines, he passes at once to a discussion of the principles of flight, and in his second chapter, within some fifty pages, the reader learns, by actual examples fully explained, how to make practically all the fundamental calculations required in estimating the performance and characteristics of aircraft.

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[3] Published by Hodder and Stoughton. Price 21*s.* net.

In our opinion, this is one of the best features of the book. Aerodynamics is an empirical science, and design proceeds by the manipulation of experimental curves which, with rare exceptions, cannot be represented by mathematical functions; present-day developments consist almost entirely in refinement of the experimental data and of the methods of their manipulation, and thus have a tendency to obscure, for the general reader, the basic principles involved. By discarding all refinements, whilst extending his specimen calculations to cover a wide range of problems, Mr. Bairstow emphasises the fundamental principle that all design is conditioned by the experimentally determined properties of the wing section, and thus prepares his reader for an intelligent appreciation of the more detailed considerations which follow.

Chap. iii., which deals with experimental methods of measurement, as they have been developed in the aerodynamics laboratories, is characterised by the same breadth of view and neglect of unnecessary refinement. In it the reader, now initiated into the problems which the science of aerodynamics has to solve, learns how these problems are attacked on the experimental side, and what order of accuracy may reasonably be expected in their solution. The account given on p. 115 of the theory of model experiments on non-rigid airship envelopes might seem to suggest that the model scale should be chosen so as to give (in theory) *equality* of fabric tensions, whereas actually, of course, it is easy to obtain *proportionality* in a model of any scale, and increase in scale has the advantage that it reduces the error introduced by the weight of the fabric. Again, we could have wished that some description had been included of the "cascade" experiment on aerofoils, which seems so promising a line of development for propeller theory; but from a footnote on p. 290 we gather that the technique of this experiment had not been fully worked out at the time of writing.

Considerations of space prevent us from dealing as we could have wished with chap. vii., an admirable *résumé* of the investigations which have been made—without very much result, so far, as regards their practical application—into the theory of fluid motion, and with chap. viii., in which the author states his present position on the question of "scale effect." Not long ago this was a question which divided aeronautical experts into two fiercely warring bands: but the heat of that battle has since died down, and we imagine that few will take exception to Mr. Bairstow's summing up of the position. Scale effect, or at any rate its possibility, is indicated by theory; it is proved beyond question to exist in many of the problems which can be investigated in wind-channels; and it may very well be present to a troublesome degree in many of the problems which concern the complete aircraft: but the order of accuracy hitherto attainable in full-scale work is too far below the ordinary standard of wind-channel work to justify us in attributing to scale effect every discrepancy which has been discovered in the comparison of model and full-scale data.

The remainder of the book, which analyses and applies the design data from the aerodynamics laboratories, scarcely affords suitable material for criticism on a first reading; ultimately these chapters must be judged by the service which they render, in daily use, to the design office and the laboratory. We shall content ourselves by mentioning one particular in which, as we believe, the book could be improved in a second edition. We do not think it is merely a personal preference which has been disappointed by the scantiness of the references in this volume to original sources of information, and to authors; in our opinion, the more authoritative a book is, the more importance attaches to complete references, whereby the reader is assisted in pursuing his investigations into any particular question which interests him. We hold, too, that the mention of authors' names is important for other reasons than the mere gratification of their personal vanity; it is an aid to memory and to verbal discussion (how otherwise—to take examples at random—shall we attain to the definiteness of meaning which we associate with "Lenz's law," the "Rankine cycle," "Bernoulli's equation," or the "Willan's line"?); and it is of enormous assistance to the reader in helping him to fit each new fact or theory into his mental picture of the scientific structure. We might add that consistency demands either the suppression of all references to individuals (which is no longer thinkable) or the adoption of the course which we advocate: no one would accuse Mr. Bairstow of partiality (and if a refutation of the charge were wanted, it could be found in the entire absence of all reference to his own part in the work which he describes), yet we have been struck by the apparent arbitrariness with which authors' names have been included or suppressed. We are conscious that it would be very difficult to give complete references at the present time, mainly because of the unfortunate preference for anonymous reports which was so prevalent in the early days of the war; but this difficulty should be removed by the publication of the reports in their final form, and we shall hope then to see those additions which will make this book the standard work of reference in its subject.

The printing and paper of the book are good, and a special word of praise is due to the illustrative diagrams, which appear to have been re-drawn specially for this work. The book is thick and rather heavy, and those who will make it a work for daily reference will probably find it desirable to clothe it in rather stronger binding.

Gymnospermic History.

Fossil Plants: A Text-book for Students of Botany and Geology. By Prof. A. C. Seward. Vol. iv.: *Ginkgoales, Coniferales, Gnetales.* (Cambridge Biological Series.) Pp. xvi+543. (Cambridge: At the University Press, 1919.) Price 1 guinea net.

TO every science, works which bring together the data of the subject are essential, and to none more so than to palæobotany, which is based on the correlation of fragmentary remains from all countries and of all ages. Prof. Seward has served his science well in completing the almost Herculean task of writing a text-book covering the whole field of these plant remains. The first volume appeared many years ago, and this, the fourth, is the final one of the series.

This disappointingly closes with the higher Gymnosperms, the series of plant families treated, and the author does not propose to continue the work so as to deal with the flowering plants. This is perhaps scarcely surprising, as the data bearing on the flowering plants are very complex and of a fragmentary and unsatisfactory nature, and have, moreover, been little studied in this country. Some up-to-date handling of the Angiosperms is greatly to be desired, and students will await with some impatience the appearance of the independent work Prof. Seward promises, in which he proposes to deal with the generalities of plant distribution, taking the fossil Angiosperms into account.

Prof. Seward's text-book should be a useful tool, not only to palæobotanists in particular, but also to all students of either botany or geology in general. Somewhat lost sight of in the mass of fossil species, there are, prefacing each group, excellent accounts of the living representatives of each family.

In a volume of such laborious detail as the present one, which appeals to the specialist rather than to the average layman, there must, of course, be many comparative trifles which tend to sidetrack any critic by inducing an attempt to deal with minor controversial matter. To do this, however, in a general review would be both ungenerous and unfair, because the amount of public recognition and the gratitude which scientific authors receive is small and out of proportion to the labour and to the sacrifice involved in their tasks.

Misprints are remarkably few, and the general perspective of presentation is well preserved, although here and there the author has naturally indulged in rather longer descriptions of one or two individual species which are first published in this book than such specimens would be allowed had they been published separately at an earlier date. It is doubtful, as a matter of general policy, whether a text-book is the place to publish new species at all, although any research worker must have in his notes records of small and relatively unimportant species which scarcely deserve independent memoirs, and the temptation to put them in the text-book must be very great.

Knowledge of the higher Gymnosperms largely depends on petrified material of secondary timber, for although fragments of foliage impressions with a few cones are known, they are compara-